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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	**09/931,268**
Applicant	:	Linlin Chen et al.
Filed	:	August 16, 2001
TC/A.U.	:	1743
Examiner	:	Alex Noguerola
Confirmation No.	:	2230
Docket No.	:	1921.0014C
Customer No.	:	27896
Title	:	AUTOMATED CHEMICAL MANAGEMENT SYSTEM EXECUTING IMPROVED ELECTROLYTE ANALYSIS METHOD

Mail Stop Petitions
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

ATTN: ***Office of Petitions***
Senior Petitions Attorney Patricia Faison-Ball

TRANSMITTAL

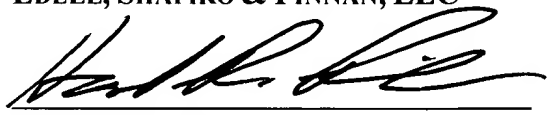
Enclosed are the following documents for the above-identified application:

Request for Reconsideration of Petition Under 37 CFR §1.47(a) (2 pages);
Date Stamped Receipt (June 6, 2003) for Revocation and New Power by Assignee & Statement Under 37 CFR §3.73(b) (1 page);
Revocation and New Power by Assignee & Statement Under 37 CFR §3.73(b) w/Assignment, filed June 6, 2003 (4 pages);
New Declaration Signed by Lyndon W. Graham (3 pages);
New Declaration Signed by Linlin Chen (3 pages);
Letter to Lyndon W. Graham dated May 12, 2004 (1 page);
Copy of Fedex Label to Lyndon W. Graham mailed May 12, 2004 (1 page);
Copy of Unsigned Declaration forwarded to Lyndon W. Graham (3 pages);
Copy of Specification, Claims, Drawings forwarded to Lyndon W. Graham (29 pages) ;
Copy of Preliminary Amendment dated June 25, 2003 for 09/931,268 forwarded to Lyndon W. Graham (3 pages);

Copy of Preliminary Amendment dated November 10, 2003 for 09/931,268 forwarded to Lyndon W. Graham (8 pages); and
Copy of Return Envelope to Howard R. Richman sent to Lyndon W. Graham (1 page).

Respectfully submitted by
EDELL, SHAPIRO & FINNAN, LLC

Dated: June 14, 2004

By: 

Howard R. Richman
Reg. No. 41,451

EDELL, SHAPIRO & FINNAN, LLC
CUSTOMER NO. 27896
1901 Research Boulevard, Suite 400
Rockville, MD 20850
(301) 424-3640

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	**09/931,268**
Applicant	:	Linlin Chen et al.
Filed	:	August 16, 2001
TC/A.U.	:	1743
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Title	:	AUTOMATED CHEMICAL MANAGEMENT SYSTEM EXECUTING IMPROVED ELECTROLYTE ANALYSIS METHOD

Mail Stop Petitions
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

ATTN: ***Office of Petitions***
Senior Petitions Attorney Patricia Faison-Ball

REQUEST FOR RECONSIDERATION OF PETITION UNDER 37 CFR §1.47(a)

During a telephone conference with Senior Petitions Attorney Patricia Faison-Ball on June 7, 2004, the undersigned was informed that a Decision Refusing Status Under 37 CFR §1.47(a) was mailed in connection with the above-referenced application on May 3, 2004. Attorney Faison-Ball advised the undersigned that this Decision had been sent to Applicants' prior counsel and that the Revocation and New Power by Assignee and Statement Under 37 CFR §3.73(b) filed by the undersigned in the USPTO on June 6, 2003 has not made it into the imaged USPTO filewrapper, and thus the correspondence address for the above-referenced application has not been changed to the undersigned's address. Applicants respectfully request that the Revocation and New Power by Assignee and Statement Under 37 CFR §3.73(b) filed by the undersigned in the USPTO on June 6, 2003 (copy attached hereto) be entered into the filewrapper and that the correspondence address for the above-referenced application be changed as requested therein.

Regarding the Decision Refusing Status Under 37 CFR §1.47(a), the undersigned has recently been able to make contact with the Inventor (Lyndon Graham) who originally did not return his Declaration for filing with the application. As shown in the attached letter to Mr. Graham sent via Federal Express by the undersigned on May 12, 2004, Mr. Graham was again given the opportunity to execute a Declaration in connection with the above-referenced application. In addition to the Declaration to be executed, the letter also included copies of the as-filed specification, claims, drawings, and two preliminary amendments (filed June 25 and November 10, 2003). Mr. Graham has now executed a Declaration for the above-referenced application.

The executed Declaration includes a reference to the application's serial number, the two preliminary amendments (filed June 25 and November 10, 2003 respectively), and corrects the position within the Declaration of the PCT priority document to the parent application (09/387,084). The listing of the PCT priority document to the parent application has been moved from the 35 U.S.C. §119 and/or §365 section of the Declaration to its correct position in the 35 U.S.C. §120 section of the Declaration. The other Inventor in this application (Linlin Chen) has also executed a new Declaration. Copies of these executed Declarations are attached hereto for your reference. Therefore, Applicants respectfully request that the above-referenced application no longer be considered to be filed under 37 CFR §1.47(a) as the attached Declarations satisfy the formal filing requirements.

Should any other information be required to expedite the processing of this application, Attorney Faison-Ball should feel free to contact the undersigned at the phone number listed below.

Dated: June 14, 2004

Respectfully submitted by
EDELL, SHAPIRO & FINNAN, LLC

By: 
Howard R. Richman
Reg. No. 41,451

EDELL, SHAPIRO & FINNAN, LLC
CUSTOMER NO. 27896
1901 Research Boulevard, Suite 400
Rockville, MD 20850
(301) 424-3640

Attorney Docket No: 1921.0014C

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of Linlin Chen et al.

Serial No.:	09/931,268	Examiner:	Not Yet Assigned
Filed:	August 16, 2001	Art Unit:	Not Yet Assigned
For:	AUTOMATED CHEMICAL MANAGEMENT SYSTEM EXECUTING IMPROVED ELECTROLYTE ANALYSIS METHOD		

BOX ASSIGNMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

The stamp of the U.S. Patent and Trademark Office placed hereon will indicate the date of receipt of the following:

Revocation and New Power by Assignee and
Statement Under 37 C.F.R. §3.73(b) (2 pages); and

Assignment document (2 pages).

Hand Delivered: June 6, 2003

Attorney Docket No: 1921.0014C

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of Linlin Chen et al.

Serial No.:	09/931,268	Examiner:	Not Yet Assigned
Filed:	August 16, 2001	Art Unit:	Not Yet Assigned
For:	AUTOMATED CHEMICAL MANAGEMENT SYSTEM EXECUTING IMPROVED ELECTROLYTE ANALYSIS METHOD		

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

REVOCATION AND NEW POWER BY ASSIGNEE AND STATEMENT UNDER 37 C.F.R. §3.73(b)

Except for the power granted to Harry M. Cross, Jr., Registration No. 22,229, the Assignee of the entire right, title, and interest in the above-identified application hereby revokes all previously granted powers and additionally grants the registered practitioners of Edell, Shapiro & Finnan, LLC included in the Customer Number provided below power to act, prosecute, and transact all business in the U.S. Patent and Trademark Office in connection with this application, any applications claiming priority to this application, and any patents issuing therefrom.

The assignee certifies that to the best of its knowledge and belief it is the owner of the entire right, title, and interest in and to the above-identified application as evidenced by:

X An assignment document by Linlin Chen, a copy of which is enclosed herewith; and

X An assignment by Lyndon W. Graham previously recorded in the U.S. Patent and Trademark Office at Reel 010500, Frame 0036.

Please direct all telephone calls and correspondence to:

Howard R. Richman
Edell, Shapiro & Finnan, LLC
1901 Research Boulevard, Suite 400
Rockville, MD 20850-3164

CUSTOMER NUMBER: 27896

The undersigned (whose title is supplied below) is empowered to sign this statement on behalf of the assignee.

Date: 6/4/03

Signature: Larry A. Viano
Name: Larry A. Viano
Title: Secretary and Chief Financial Officer
Company: Semitool, Inc.

Attorney Docket No: 1921.0014C **PATENT**

ASSIGNMENT

LinLin Chen, residing at 3213 Placid Springs Lane, Plano, TX 75025 (referred to as "Assignor") has made an invention(s) (the "Invention(s)") set forth in an application for patent of the United States, entitled AUTOMATED CHEMICAL MANAGEMENT SYSTEM EXECUTING IMPROVED ELECTROLYTE ANALYSIS METHOD, and which is a:

(1) [] provisional application
- (a) [] to be filed herewith; or
- (b) [] bearing Application No. , and filed on ; or

(2) [X] non-provisional application
- (a) [] to be filed herewith; or
- (b) [X] bearing Application No. 09/931,268, and filed on August 16, 2001.

WHEREAS, **Semitool, Inc.**, having its principal place of business at 655 West Reserve Drive, Kalispell, MT 59901 (the "Assignee"), is desirous of acquiring the entire right, title, and interest in: the Invention(s); the application for patent identified in paragraph (1) or (2); the right to file applications for patent of the United States or other countries on the Invention(s); any application(s) for patent of the United States or other countries claiming priority to these application(s); any provisional or other right to recover damages, including royalties, for prior infringements of these applications; and any patent(s) of the United States or other countries that may be granted therefor or thereon.

NOW, THEREFORE, for good and sufficient consideration, the receipt of which is hereby acknowledged, and to the extent that the Assignor has not done so already via a prior agreement with the Assignee, or if the Assignor has already done so via a prior agreement with the Assignee then in confirmation of any obligation to do so in said prior agreement, the Assignor has sold, assigned, transferred, and set over, and by these presents does sell, assign, transfer, and set over, unto the Assignee, its successors, legal representatives, and assigns, the Assignor's entire right, title, and interest in:

(a) the Invention(s);

(b) the application for patent identified in paragraph (1) or (2);

(c) the right to file applications for patent of the United States or other countries on the Invention(s), including all rights under the Hague Convention, the Paris Convention for the Protection of Industrial Property, and under the Patent Cooperation Treaty;

(d) any application(s) for patent of the United States or other countries claiming the Invention(s);

(e) any application(s) for patent of the United States or other countries claiming priority to the application for patent identified in paragraph (1) or (2) or any application(s) for patent claiming the Invention(s), including any division(s), continuation(s), and continuation(s)-in-part;

(f) any provisional or other right to recover damages, including royalties, for prior infringements of any application for patent identified in the proceeding paragraphs (b)-(e); and

(g) any patent(s) of the United States or other countries that may be granted for or on any application for patent identified in the preceding paragraphs (b) – (e), including any reissue(s) and extension(s) of said patent(s).

The above-granted rights, titles, and interests are to be held and enjoyed by the Assignee, for its own use and behalf and the use and behalf of its successors, legal representatives, and assigns, as fully and entirely as the same would have been held and enjoyed by the Assignor had this sale and assignment not been made.

The Assignor hereby represents to the Assignee, its successors, legal representatives, and assigns, that, at the time of execution and delivery of these presents, or if applicable, at such time said prior agreement was executed, the Assignor is the sole and lawful owner of the entire right, title, and interest in and to the Invention(s), that the Invention(s) are unencumbered, except, if applicable, by obligation to assign in accordance with said prior agreement, and that the Assignor has good and full right and lawful authority to sell and convey the same in the manner set forth herein.

The Assignor hereby covenants and agrees to and with the Assignee, its successors, legal representatives, and assigns, that the Assignor will sign all papers and documents, take all lawful oaths, and do all acts necessary or required to be done in connection with any and all proceedings for the procurement, maintenance, enforcement and defense of the Invention(s), said applications, and said patents, including interference proceedings, without charge to the Assignee, its successors, legal representatives, and assigns, but at the cost and expense of the Assignee, its successors, legal representatives, and assigns.

The Assignor hereby requests the Commissioner of Patents to issue said patents of the United States to the Assignee for the sole use and behalf of the Assignee, its successors, legal representatives, and assigns.

Date: 4/19/03 By: _____

State of TEXAS)
ss.
County of COLLIN)

On April 17, 2003, before me, John S. TENNENT, personally appeared Linlin Chen, personally known to me or proved to me on the basis of satisfactory evidence, to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

_____
Signature of Notary Public

JOHN S. TENNENT
Notary Public, State of Texas
My Commission Expires
February 26, 2007

Place Notary Seal Above

Attorney Docket No: 1921.0014C

PATENT

DECLARATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Automated Chemical Management System Executing Improved Electrolyte Analysis Method

the specification of which:

(check one)

☐ is attached hereto;

☒ was filed as United States Application Serial No. 09/931,268 on August 16, 2001, and was amended on June 25, 2003, and November 10, 2003 (if applicable);

☐ was filed as PCT International Application No. _____ on _____ and was amended under PCT Article 19 or Article 34 on _____ (if applicable);

I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above;

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information which is known to me to be material to the patentability of said invention in accordance with 37 C.F.R. §1.56;

I hereby claim foreign priority benefits under 35 U.S.C. §119 and/or §365 of any foreign application(s) for patent, any foreign application(s) for inventor's certificate, or any PCT international application(s) designating at least one country other than the United States of America listed below; I have also identified below any foreign application(s) for patent, any foreign application(s) for inventor's certificate, or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

Prior Foreign Application(s)

COUNTRY/INTERNATIONAL	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			☐ YES ☐ NO
			☐ YES ☐ NO

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below:

_____ _____
(Application Number) (Filing Date) (day, month, year)

_____ _____
(Application Number) (Filing Date) (day, month, year)

I hereby claim the benefit under 35 U.S.C. §120 and/or §365 of any United States application(s) or of any international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior application(s) in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. §1.56 which became available between the filing date(s) of the prior application(s) and the national or PCT international filing date of this application:

Prior U.S. Application(s) or PCT International Applications Designating the U.S. for benefit under 35 U.S.C. §120

U.S. APPLICATIONS			**STATUS (*check one*)**		
U.S. APPLICATION NO.	U.S. FILING DATE (day, month, year)		Pending	Patented	Abandoned
09/387,084	31 August 1999		☐	☒	☐
			☐	☐	☐
PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO.	PCT FILING DATE (day, month, year)	U.S. APPLICATION NOS. (if any)			
PCT/US99/09659	3 May 1999		☐	☐	☒
			☐	☐	☐

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of first inventor: **LinLin Chen**

Inventor's signature _____ Date _____
Residence: Plano Texas 75025
Citizen of: Canada
Post Office Address: 3213 Placid Springs Lane, Plano TX 75025

Full name of second inventor: **Lyndon W. Graham**

Inventor's signature _____ Date 5/14/04
Residence: Hillsboro, Oregon 97123
Citizen of: United States
Post Office Address: 1937 SE Morgan Road, Hillsboro OR 97123

Attorney Docket No: 1921.0014C

PATENT

DECLARATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Automated Chemical Management System Executing Improved Electrolyte Analysis Method

the specification of which:

(check one)

☐ is attached hereto;

☒ was filed as United States Application Serial No. 09/931,268 on August 16, 2001, and was amended on June 25, 2003, and November 10, 2003 (if applicable);

☐ was filed as PCT International Application No. _____ on _____ and was amended under PCT Article 19 or Article 34 on _____ (if applicable);

I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above;

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information which is known to me to be material to the patentability of said invention in accordance with 37 C.F.R. §1.56;

I hereby claim foreign priority benefits under 35 U.S.C. §119 and/or §365 of any foreign application(s) for patent, any foreign application(s) for inventor's certificate, or any PCT international application(s) designating at least one country other than the United States of America listed below; I have also identified below any foreign application(s) for patent, any foreign application(s) for inventor's certificate, or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

Prior Foreign Application(s)

COUNTRY/INTERNATIONAL	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			☐ YES ☐ NO
			☐ YES ☐ NO

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below:

_____ _____
(Application Number) (Filing Date) (day, month, year)

_____ _____
(Application Number) (Filing Date) (day, month, year)

I hereby claim the benefit under 35 U.S.C. §120 and/or §365 of any United States application(s) or of any international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior application(s) in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. §1.56 which became available between the filing date(s) of the prior application(s) and the national or PCT international filing date of this application:

Prior U.S. Application(s) or PCT International Applications Designating the U.S. for benefit under 35 U.S.C. §120

U.S. APPLICATIONS			**STATUS (*check one*)**		
U.S. APPLICATION NO.	U.S. FILING DATE (day, month, year)		Pending	Patented	Abandoned
09/387,084	31 August 1999		☐	☒	☐
			☐	☐	☐
PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO.	PCT FILING DATE (day, month, year)	U.S. APPLICATION NOS. (if any)			
PCT/US99/09659	3 May 1999		☐	☐	☒
			☐	☐	☐

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of first inventor: **LinLin Chen**

Inventor's signature _____ Date 5/18/04
Residence: Plano Texas 75025
Citizen of: ~~Canada~~ U. S. A. L. C.
Post Office Address: 3213 Placid Springs Lane, Plano TX 75025

Full name of second inventor: **Lyndon W. Graham**

Inventor's signature _____ Date _____
Residence: Hillsboro, Oregon 97123
Citizen of: United States
Post Office Address: 1937 SE Morgan Road, Hillsboro OR 97123

LAW OFFICES OF
EDELL, SHAPIRO & FINNAN, LLC
1901 RESEARCH BOULEVARD
SUITE 400
ROCKVILLE, MARYLAND 20850

TELEPHONE (301) 424-3640

FACSIMILE (301) 762-4056

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IRA C. EDELL
STUART B. SHAPIRO
PATRICK J. FINNAN
HOWARD R. RICHMAN
ANDREW J. ALDAG◊
HEATHER G. MORIN+
MICHAEL E. GRENDZYNSKI Δ
WESLEY W. MULLER

OF COUNSEL:
BARBARA A. FRIEDMAN +
MARTIN ABRAMSON*+

*VA BAR ◊ WI BAR
+DC BAR Δ OH BAR

May 12, 2004

CONFIDENTIAL COMMUNICATION

VIA FEDERAL EXPRESS

Mr. Lyndon W. Graham
1937 SE Morgan Road
Hillsboro, Oregon 97123

Re: Semitool's U.S. Patent Application No. 09/931,268
Title: ***Automated Chemical Management System Executing Improved Electrolyte Analysis Method***
Our Matter No. 1921.0014C

Dear Mr. Graham:

The above-referenced patent application was filed by Semitool, Inc. on August 16, 2001. On October 8, 2001, Janice Pike, the Legal Assistant for Semitool's IP Department sent you (via Federal Express) a cover letter asking you to execute an enclosed Declaration and Power of Attorney for this patent application. On January 21, 2002, Ms. Pike repeated this process by sending you (via Federal Express) a cover letter asking you to execute an enclosed Declaration and Power of Attorney for this patent application. No response to either letter has ever been received by Semitool.

For your review, I have enclosed a copy of the specification, claims, drawings, and two preliminary amendments (filed June 25 and November 10, 2003) for U.S. Patent Application No. 09/931,268. I have also enclosed a Declaration for you to execute in connection with this application. Please sign and date the Declaration (under your name on the third page) and return the executed declaration to me in the enclosed, postage-paid envelope by no later than June 2, 2004. **Thank you for your cooperation in this matter and feel free to contact me if you have any questions.**

Sincerely,

Howard R. Richman

Enclosures: Specification, Claims, Drawings, & two Preliminary Amendments for 09/931,268
Declaration
Return Envelope

cc: Harry M. Cross, Jr., Esq. (w/Enclosures)

From: Origin ID: (301)424-3640
LORI A. PETTINATI
EDELL, SHAPIRO & FINNAN, LLC
1901 RESEARCH BLVD
SUITE 400
ROCKVILLE, MD 20850

FedEx Express

CL8032404

Ship Date: 12MAY04
Actual Wgt: 1 LB
System#: 5084117/INET1800
Account#: S *********

REF: 1921.0014c

Delivery Address Bar Code

SHIP TO: (301)424-3640 BILL SENDER
Lyndon W. Graham

1937 SE Morgan Road

Hillsboro, OR 97123

** 2DAY **

FRI
Deliver By:
14MAY04

TRK# 7912 3916 3154 FORM 0201

PDX A2

97123 -OR-US
RES

SE MRIA

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Attorney Docket No: 1921.0014C **PATENT**

DECLARATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Automated Chemical Management System Executing Improved Electrolyte Analysis Method

the specification of which:

(check one)

☐ is attached hereto;

☒ was filed as United States Application Serial No. 09/931,268 on August 16, 2001, and was amended on June 25, 2003, and November 10, 2003 (if applicable);

☐ was filed as PCT International Application No. _____ on _____ and was amended under PCT Article 19 or Article 34 on _____ (if applicable);

I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above;

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information which is known to me to be material to the patentability of said invention in accordance with 37 C.F.R. §1.56;

I hereby claim foreign priority benefits under 35 U.S.C. §119 and/or §365 of any foreign application(s) for patent, any foreign application(s) for inventor's certificate, or any PCT international application(s) designating at least one country other than the United States of America listed below; I have also identified below any foreign application(s) for patent, any foreign application(s) for inventor's certificate, or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

Prior Foreign Application(s)

COUNTRY/INTERNATIONAL	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			☐ YES ☐ NO
			☐ YES ☐ NO

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below:

_____ _____
(Application Number) (Filing Date) (day, month, year)

_____ _____
(Application Number) (Filing Date) (day, month, year)

I hereby claim the benefit under 35 U.S.C. §120 and/or §365 of any United States application(s) or of any international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior application(s) in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. §1.56 which became available between the filing date(s) of the prior application(s) and the national or PCT international filing date of this application:

Prior U.S. Application(s) or PCT International Applications Designating the U.S. for benefit under 35 U.S.C. §120

U.S. APPLICATIONS			**STATUS (*check one*)**		
U.S. APPLICATION NO.	U.S. FILING DATE (day, month, year)		Pending	Patented	Abandoned
09/387,084	31 August 1999		☐	☒	☐
			☐	☐	☐
PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO.	PCT FILING DATE (day, month, year)	U.S. APPLICATION NOS. (if any)			
PCT/US99/09659	3 May 1999		☐	☐	☒
			☐	☐	☐

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Attorney Docket No. SEM4492P1260US
Corporate Docket No. P01-0006

Express Mail Label No. EL 902647517 US

TITLE OF THE INVENTION

AUTOMATED CHEMICAL MANAGEMENT SYSTEM EXECUTING IMPROVED ELECTROLYTE ANALYSIS METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of USSN 09/387,084, filed 08/31/1999, titled "Methods and Apparatus for Controlling and/or Measuring Additive Concentration in an Electroplating Bath", which is a continuation of PCT/US99/09659, filed 05/03/1999, titled "Methods and Apparatus for Controlling and/or Measuring Additive Concentration in an Electroplating Bath", both of which are herby incorporated by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

BACKGROUND OF THE INVENTION

One technology that is rapidly coming to the forefront for the formation of microelectronic devices and components is electrochemical deposition, which includes both electroplating and electroless plating of metal to form microelectronic features on a microelectronic workpiece. Though electrochemical deposition has long been employed as a fundamental step in fabrication of multilevel printed circuit boards, application of electrochemical deposition to fill sub-micron

interconnect features is relatively recent and poses further additional problems, including the need for more stringent control of the electrolyte bath composition.

Electrochemical deposition is a complex process involving multiple ingredients in the electrolytic bath. If the electrolytic bath is to provide high-quality deposited films (blanket or patterned) on the surface of the substrate, the concentration of several of the constituents of the bath should be maintained. As such, the ability to monitor and control the composition of the bath is one of the important factors in ensuring uniform and reproducible film properties. In semiconductor and microelectronic component applications, the electronic and morphological properties of the metal films are of principal importance in determining final device performance and reliability. The stability of later microfabrication processes in the manufacturing sequence likewise frequently depends on repeatable mechanical properties, including modulus, ductility, hardness, and surface texture of the deposited material. All of these deposit properties are controlled or strongly influenced by the composition of the electrolytic bath.

Measurement and control of proprietary organic compounds that serve to modify the deposit properties through adsorption onto and desorption from the cathode surface during, for example, electroplating, are important since they affect the diffusion rate of metal cations to nucleation and growth sites. These compounds are typically delivered as multi-component packages from chemistry vendors. One of the functions of the additive packages is to influence the throwing power of the electroplating bath: the relative insensitivity of plating rate to variations in cathodic current density across the wafer or in the vicinity of surface irregularities. The throwing power of the electrolyte has

an effect on the cross-wafer uniformity of deposited film thickness and the success with which ultrafine trenches and vias (holes) are filled without included seams or voids. Organic additives have also been shown to have substantial effects on mechanical film properties. Detection and quantification of these bath constituents is complicated by the fact that they are effective at very low concentrations in the electrolyte, for example, at several ppm or less.

Bath analysis for microelectronic applications is strongly driven by the need to limit variability and maintain device yields through maintenance of optimized process parameters. One method for controlling such ingredients in an electroplating bath is to make regular additions of particular ingredients based upon empirical rules established by experience. However, depletion of particular ingredients is not always constant with time or use. Consequently, the concentration of the ingredients is not actually known and the level in the bath eventually diminishes or increases to a level where it is out of the acceptable concentration range. If the additive content concentration deviates too far from the target value, the quality of the deposit suffers and the deposit may be dull in appearance and/or brittle or powdery in structure. Other possible consequences include low throwing power and/or plating folds with bad leveling. Accordingly, further evaluation techniques may be used instead of or in an addition to the more conventional empirical techniques.

One method for evaluating the quality of an electroplating bath is disclosed in Tench U.S. Pat. No. 4,132,605 (hereafter the Tench patent). In accordance with the procedures of the Tench patent, Figure 1 of which is illustrated here, the potential of a working electrode 10 is swept through a voltammetric cycle, including a metal plating range and a metal stripping range, for at least two

baths of known plating quality and an additional bath whose quality or concentration of brightener is to be evaluated. The integrated or peak current utilized during the metal stripping range is correlated with the quality of the bath of known quality. The integrated or peak current utilized to strip the metal in the bath of unknown quality is compared to the correlation and its quality evaluated. In a preferred embodiment of said patent, the potential of an inert working electrode 10 is swept by a function generator through the voltammetric cycle. An auxiliary electrode 20 immersed in the plating bath is coupled in series with a function generator and a coulometer to measure the charge from the working electrode 10 during the stripping portion of the cycle.

An improvement to the method disclosed in the Tench patent is described by Tench and White, in the *J. Electrochem. Soc.*, "Electrochemical Science and Technology", April, 1985, pp. 831-834 (hereafter the Tench publication). In accordance with the Tench publication, contaminant buildup in a copper plating bath affects the copper deposition rate, and thus interferes with brightener analysis. The Tench publication teaches a technique that involves sequentially pulsing the electrode between appropriate metal plating, metal stripping, cleaning, and equilibrium potentials whereby the electrode surface is maintained in a clean and reproducible state. The method set forth in that publication is in contrast to the continuous sweep cycle utilized in the above-referenced patent. Stated otherwise, whereas the process of the Tench patent involves a continuous voltammetric sweep between about -600 mV and + 1,000 mV versus a working electrode and back over a period of about 1 minute, the Tench publication pulses the potential, for example at -250 mV for 2 seconds to plate, + 200 mV for a time sufficient to strip, + 1,600 mV to clean for several seconds, + 425 mV for 5

seconds to equilibrate, all potentials referenced to a saturated Calomel electrode. After the foregoing, the cycle is repeated until the difference between successive results are within a predetermined value range, for example, within 2% of one another.

Although the procedure of the Tench publication provides some improvement over the procedure of the Tench patent, the present inventor has recognized several areas that need improvement. For example, neither of the foregoing methods suitably address the measurement of individual constituents of electrochemical baths having two or more constituents.

BRIEF SUMMARY OF THE INVENTION

A method for determining the concentration of an additive X of an electrochemical bath that includes at least one further component Y is set forth. In accordance with the method, a predetermined amount of a starting solution is provided. The starting solution comprises virgin makeup solution that is saturated with the further additive, or forms a mixed solution that is saturated with the further additive when combined with an amount of the electrochemical bath for measurement that is extracted for measurement. A predetermined amount of the extracted electrochemical bath is then added to the predetermined amount of the starting solution to form the mixed solution. At least one electroanalytical measurement cycle it is then executed using the mixed solution and the results of the measurement cycle are compared with a known measurement standard.

The teachings associated with the foregoing method may be used to implement a corresponding method in an automatic analysis and dosing system. More particularly, a method for determining the amount of an electrochemical bath additive that is to be automatically added to an electrochemical bath by the dosing system is also set forth. In accordance with this method, the amount of the electrochemical bath additive that is to be added it is dependent on a measurable value related to an amount of a component X in the electrochemical bath that is to be measured. As above, the electrochemical bath also includes at least one further component Y. The automatic analysis and dosing system is programmed to provide a predetermined amount of a starting solution that is comprised of virgin makeup solution that is saturated (or otherwise -- see above) with the further component Y. An amount of the electrochemical bath is then automatically extracted for measurement and a predetermined amount of the extracted electrochemical bath is automatically

added to the predetermined amount of the starting solution to form a mixed solution that is substantially saturated with the further component Y. At least one electroanalytical measurement cycle is then executed using the mixed solution and the results of the electroanalytical measurement cycle are used to determine the amount of additive that is to be dispensed by the dosing system.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Figure 1 is an illustration of the basic components of an electrochemical cell that may be used to implement one or more of the disclosed electroanalytical methods in accordance with the teachings of the present invention.

Figure 2 is a flowchart illustrating a process sequence used to analyze an electrolytic bath in accordance with one embodiment of the present invention.

Figure 3 is a flowchart illustrating a further process sequence used to analyze an electrolytic bath in accordance with a further embodiment of the present invention.

Figure 4 is a graph illustrating experimental results obtained using a process sequence derived from the flowchart of Figures 2 and 3.

Figure 5 is a schematic block diagram of one embodiment of an analysis and dosing system that that may be used to implement the processes of Figures 2 and 3 .

DETAILED DESCRIPTION OF ONE OR MORE EMBODIMENTS OF THE INVENTION

In order to comprehend the context of the present invention, an understanding of the various techniques suitable for analyzing an electroplating bath is helpful. To this end, a description of certain bath analysis techniques are set forth.

A major category of analysis suitable for monitoring an electroplating bath is electroanalysis. Electroanalytical methods use electrically conductive probes, called electrodes, to make electrical contact with an electrochemical bath that is to be analyzed. Such electrochemical baths are used, for example, to electroplate a metal or the like onto the surface of a microelectronic workpiece. The electrodes are used in conjunction with electronic devices to which they are attached to provide electrical energy to a sample extracted from the bath and measure a corresponding electrical parameter response of the sample to the electrical energy. The measured parameter, in turn, is indicative of the type and/or quantity of additives in the electrochemical bath.

Faradaic electroanalysis is attractive as an investigative analytical method principally because what is studied is the electrochemical activity of the bath sample under applied electrical stimulus; the measured responses are related in a fundamental way to the properties that influence the quality of the metal deposition process itself. Electroanalysis further offers the opportunity to study the mechanisms and kinetics of the plating process, and the influences that various electrochemical bath components exert on plating rate suppression and acceleration.

Generally stated, electroanalytical methods are divided into categories according to the electrical parameters that are measured. The major electroanalytical methods include potentiometry, amperometry, conductometry, voltammetry (and polarography), and coulometry. The names of the methods reflect the measured electrical property or its units. Potentiometry measures electrical potential (or voltage) while maintaining a constant (normally nearly zero) electrical current between the electrodes. Amperometry monitors electrical current (amperes). Conductometry measures conductance (the ability of a solution to carry an electrical current). Coulometry is a method that monitors the quantity of electrical charge (coulombs) that is consumed during an electrochemical reaction involving the analyte.

Voltammetry is a technique in which the potential is varied in a regular manner while the current is monitored. Voltammetry (or amperometry) involves the investigation of the current that develops in an electrochemical cell as a consequence of applied potential between a working and auxiliary electrode pair, with the potential measured against a suitable reference electrode.

Figure 1 is a schematic diagram of a basic electroanalytical cell. In the basic cell, three electrodes are immersed in a container 40: a working electrode 10, an auxiliary electrode 20, and a reference electrode 30. The reference electrode 30 may, for example, be a Ag/AgCl double junction or Saturated Calomel Electrode (SCE). The working electrode 10, for example, may be one of several types, including a drop mercury electrode (DME), a hanging mercury drop electrode (HMDE), a mercury thin film electrodes (MTFE), or an inert electrode which may be either stationary or of a rotating electrode configuration (e.g., RRDE, RCE, RDE). While the

mercury-based electrodes offer the advantage of a surface that can be periodically 'renewed' to offer immunity to drift in electrochemical responses associated with changes in surface conditions (e.g., deposit build-up or smutting), inert RDE-type working electrodes with Pt, Pd, Ir, or Rh surfaces are most often employed in systems dedicated to plating bath analysis for convenience of system set-up, maintenance, and waste handling. The apparatus of Figure 1 employs an RDE-type electrode in which relative motion between the working electrode 10 and the bath is established by a motor (not illustrated) that rotates the working electrode 10. Electrical contact to the working electrode 10 is made by, for example, slip brushes or the like. Neither the processes nor the apparatus of the present invention are limited to a particular electrode type or electroanalytical cell configuration.

A computer or similar control system may be used to control an electronic potentiostat that, in turn, controls the energy input to the working electrode 10 and the reference electrode 30. Using a suitable program, one or more energy input sequences may be applied to the electroanalytical cell to obtain measurement that are used in determining the amount of a target constituent, such as a bath additive.

One of the difficulties encountered when trying to determine the amount of a constituent in an electrochemical bath is the fact that most electrochemical baths include a variety of different constituents. Many of these constituents are additives that are proprietary to the particular company providing the electrochemical bath. These constituents/additives generally have different effects on the electrochemical deposition process. For example, some additives enhance electroplating while others act as electroplating suppressors that inhibit electroplating. It is therefore difficult to execute

some electroanalysis techniques that rely on the plating and/or stripping of a metal onto or from an electrode in determining the amount of a particular additive, such as an enhancer or suppressor in the electroplating bath.

Figure 2 is a flowchart illustrating one embodiment of a method that may be used to determine the concentration of a target constituent/additive (these terms are used synonymously herein). As illustrated at step 210, an amount of the electrochemical bath is extracted from, for example, an apparatus that is using the bath to deposit a material onto the surface of a microelectronic workpiece. The electrochemical bath is comprised of at least two additives/constituents: X and Y . The concentration, or other measurable quantity, of at least one of the additives of the electrochemical bath is to be measured. For purposes of the following description, it will be assumed that additive/constituent X is the target constituent that is to be measured. As will be set forth below, the quantity of X that is measured can be used to determine the proper amount of X and/or other bath additives that are to be added to the electrochemical bath by a corresponding dosing system.

In another step, shown here as step 215, a predetermined amount of a starting solution is provided. Steps 210 and 215 may be executed serially, in no particular order, or concurrently. It is for this reason that they are shown here as separate parallel operations.

Generally, additive/constituent Y will have an impact on any electroanalytical measurements that are taken to determine the quantity of additive X that is present in the electrochemical bath. Additive/constituent Y may be comprised of one or more different chemicals that are purposely

added to the electrochemical bath and/or are bath byproducts. In order to negate the effect that additive/constituent Y has on subsequent electroanalytical measurements involving both the electrochemical bath sample and the starting solution, the starting solution is chosen so that it is comprised of virgin makeup solution that is saturated with the additive/constituent Y. Alternatively, or in addition, the amount of additive/constituent Y present in the starting solution may be chosen so that the total amount of additive/constituent Y in a mixed solution that includes a predetermined amount of the starting solution and a predetermined amount of the electrochemical bath renders the effect of additive/constituent Y negligible. For example, the amount of additive/constituent Y present in the starting solution plus an empirically, or otherwise, determined amount of additive/constituent Y in the electrochemical bath renders a mixed solution that is saturated with additive/constituent Y. An example of a process employing this latter method of insuring saturation of the additive/constituent is illustrated at steps 310 through 320 of Figure 3.

At step 220, a predetermined amount of the extracted electrochemical bath is added to a predetermined amount of the starting solution. An electroanalytical measurement cycle is executed at step 225 on the mixed solution resulting from step 220. In accordance with one embodiment of the illustrated method, the electroanalytical measurement cycle may comprise a voltammetric technique such as CVS and/or CPVS. The result of the electroanalytical measurement cycle is then compared with one or more measurement standards at step 230. For example, the result of the electroanalytical measurement cycle may be compared to data representing a graph of known standard solutions that have been subject to such an electroanalytical measurement cycle.

Alternatively, or in addition, the result of the electroanalytical measurement cycle may be used, either alone or with other electroanalytical measurement cycle results, in a mathematical calculation. This mathematical calculation, in turn, may be used alone, as the basis for comparison with known standard values, or in other mathematical calculations to determine the amount of additive/constituent X in the extracted bath sample or to determine the amount of a particular additive/constituent that is to be added by the corresponding dosing system.

In accordance with one embodiment of this method, a calibration curve is derived using a standardized solution that is saturated with both additive/constituent X and additive/constituent Y. This is done so that the same volumetric change occurs independent of whether the plating bath or the standard solution is added. As such, the volumetric change does not have a significant effect on the determination of the amount of the target constituent/additive that is present in the electrochemical bath.

Fig. 4 is a graph illustrating the results obtained when additive/constituent X is an electroplating suppressor, additive/constituent Y is an electroplating enhancer and CVS is used as the electroanalytical technique. As shown, the ratio of strip areas reduction is plotted along the vertical axis while the volume of standard solution/electroplating bath is plotted along the horizontal axis. Curve 405 represents the results obtained with the standard solution while curve 410 represents the results obtained using the extracted electroplating bath sample. In accordance with one manner of implementing the methods shown in Figures 2 and 3, the electroanalytical measurement cycle may be conducted in the manner set forth in USSN 09/387,084, entitled "Methods and Apparatus for

Controlling and/or Measuring Additive Concentration in an Electroplating Bath", filed August 31, 1999.

Further electroanalytical measurements may be taken, if desired, as shown at step 235. For example, an electroanalytical measurement cycle, such as at 225, may be executed on a further predetermined amount of the extracted electrochemical bath and/or the starting solution. Such a process is exemplified by return line 240. Alternatively, or in addition, a further electroanalytical measurement cycle may be executed on the same mixed solution. This option is illustrated at return line 245. It should be noted, however, that the analysis may be terminated without further repetition.

The foregoing analysis techniques may be implemented in an electroanalysis unit that is integrated with a dosing system for use with electroplating tools that are used at microelectronic fabrication facilities. Most known systems, however, execute the dosing function using open-loop, predetermined models that replenish the electroplating bath constituents based on empirically determined data. Such systems may be suitable for certain electroplating processes, but become less viable as new device requirements impose more rigorous standards on the make-up of the electroplating bath.

More accurate control of the plating bath constituents may be obtained using a dosing system that employs measurement feedback to ascertain the proper quantity of a bath additives that is to be dispensed. An exemplary feedback dosing system that may implement the foregoing process is is illustrated in Figure 5. As shown, the dosing system, shown generally at 500, includes a central processor 505 that is used to control the operations necessary to perform the following functions: 1)

extract a sample of the electroplating bath that is to be analyzed; 2) execute an electroanalytical technique on the electroplating bath sample; 3) calculate the amount of the electroplating bath constituent present in the sample based on the results of the electroanalytical technique or otherwise derived a similarly useful indication of the effect of the constituent; and 4) use the resulting calculation to automatically control the supply of an amount of the constituent to replenish the electroplating bath, raising the constituent concentration to a predetermined level.

In order to execute such functions, the central processor 505 is connected to interact with and exchange information with a number of further units and systems. A bath sample extraction unit 510 is connected for control by the central processor 505. The bath sample extraction unit 510 is connected to receive electroplating solution along line 520 from the principal electroplating bath 515 in response to control signals/commands received from the central processor 105 along communication link 525. In response to such control signals/commands, the bath sample extraction unit 510 provides the bath sample to either an electroanalytical cell 40 of electroanalysis unit 530 or to a titration system 535.

Both the electroanalysis unit 530 and the titration system 535 are under the control of the central processor 505. The central processor 505 coordinates the activities of the electroanalysis unit 530 and titration system 535 to execute the desired electroanalytical technique. The central processor 105 then acquires the requisite data based on the electroanalytical technique to directly calculate or otherwise determine in a relative manner the concentration of the plating bath constituent. Based on this calculation/determination, the central processor 505 directs one or more

constituent dosing supply units 540 to provide the necessary amount of the constituent (or amount of solution containing the constituent) to the electroplating bath 515, thus completing the feedback control process.

It will be recognized that the electroanalytical apparatus and techniques described above can be implemented in a manual, semi-automatic, or completely automatic manner. Dosing system 5 00 is provided as an illustrative, yet novel manner in which to implement one or more of the methods described above, as well as similar methods based on the teachings of the present application.

Numerous modifications may be made to the foregoing system without departing from the basic teachings thereof. Although the present invention has been described in substantial detail with reference to one or more specific embodiments, those of skill in the art to the will recognize that changes may be made thereto without departing from the scope and spirit of the invention as set forth in the appended claims.

CLAIMS

1. A method for determining the concentration of an additive X of an electrochemical bath that includes at least one further component Y, the method comprising:

providing a predetermined amount of a starting solution, the starting solution comprising virgin makeup solution that is saturated with the further additive;

extracting an amount of the electrochemical bath for measurement;

adding a predetermined amount of the extracted electrochemical bath to the predetermined amount of the starting solution to form a mixed solution;

executing at least one electroanalytical measurement cycle using the mixed solution;

comparing results of the electroanalytical measurement cycle with a known measurement standard.

2. The method of claim 1 wherein a plurality of electroanalytical measurement cycles are executed using the mixed solution and wherein the mixed solution used in the electroanalytical measurement cycles comprises mixed solutions having different amounts of the extracted electrochemical bath added thereto.

3. The method of claim 1 wherein the at least one electroanalytical measurement cycle comprises cyclic voltammetric stripping.

4. The method of claim 1 wherein the at least one electroanalytical measurement cycle comprises cyclic pulse voltammetric stripping.

5. The method of claim 1 wherein the known measurement curve is obtained by executing a plurality of electroanalytical measurement cycles using a standardized solution comprising virgin makeup solution that is saturated with the additive X and the further component Y.

6. The method of claim 1 wherein the additive X is an electroplating suppressor.

7. The method of claim 1 wherein the component Y is an electroplating enhancer.

8. A method for determining the concentration of suppressor in an electroplating bath that also includes an electroplating enhancer, the method comprising:

providing a predetermined amount of a starting solution comprising virgin makeup solution that is saturated with the enhancer;

extracting an amount of the electroplating bath for measurement;

adding a predetermined amount of the extracted electroplating bath to the predetermined amount of the starting solution to form a mixed solution;

executing at least one electroanalytical measurement cycle using the mixed solution;

comparing results of the at least one electroanalytical measurement cycle with a known measurement curve.

9. The method of claim 8 wherein a plurality of electroanalytical measurement cycles are executed using the mixed solution and wherein the mixed solution used in the electroanalytical measurement cycles comprises mixed solutions having different amounts of the extracted electroplating bath added thereto.

10. The method of claim 8 wherein the at least one electroanalytical measurement cycle comprises cyclic voltammetric stripping.

11. The method of claim 8 wherein the at least one electroanalytical measurement cycle comprises cyclic pulse voltammetric stripping.

12. The method of claim 8 wherein the known measurement curve is obtained by executing a plurality of electroanalytical measurement cycles using a standardized solution comprising virgin makeup solution that is saturated with the enhancer and suppressor .

13. A method for determining the concentration of an additive X of an electrochemical bath that includes at least one further component Y, the method comprising:

providing a predetermined amount of a starting solution, the starting solution comprising virgin makeup solution that includes a predetermined amount of the further additive;

extracting an amount of the electrochemical bath for measurement;

adding a predetermined amount of the extracted electrochemical bath to the predetermined amount of the starting solution to form a mixed solution, the mixed solution being saturated with the at least one further component Y;

executing at least one electroanalytical measurement cycle using the mixed solution;

comparing results of the electroanalytical measurement cycle with a known measurement standard.

14. A method for determining the amount of an electrochemical bath additive that is to be automatically added to an electrochemical bath by a dosing system, the amount of the electrochemical bath additive that is to be added being dependent on a measurable value related to an amount of a component X in the electrochemical bath, the electrochemical bath also including at least one further component Y, the method comprising:

providing a predetermined amount of a starting solution, the starting solution comprising virgin makeup solution that is saturated with the further component Y;

automatically extracting an amount of the electrochemical bath for measurement;

automatically adding a predetermined amount of the extracted electrochemical bath to the predetermined amount of the starting solution to form a mixed solution;

automatically executing at least one electroanalytical measurement cycle using the mixed solution;

automatically using the results of the electroanalytical measurement cycle to determine the amount of additive that is to be dispensed by the dosing system.

15. The method of claim 14 wherein the electroanalytical measurement cycle comprises cyclic voltammetric stripping.

16. The method of claim 14 wherein the electroanalytical measurement cycle comprises cyclic pulse voltammetric stripping.

17. An automated chemical management system comprising:

a bath extraction system connected to extract an amount of an electrochemical bath from an electrochemical processing unit, the bath extraction unit being adapted to extract an electrochemical bath that is comprised of a first bath additive, the amount of which is to be determined by the automated chemical management system, and a second bath additive,

an electroanalytical measurement system including a container in which electroanalytical measurements are conducted, the container being adapted to hold an amount of virgin makeup solution that is saturated with the second bath additive,

a programmable control system connected to control the bath extraction system and the electroanalytical measurement system, the programmable control system being programmed to direct the bath extraction system and electroanalytical measurement system for execution of a series of operations to determine the amount of the first bath additive in the electrochemical bath that has been extracted from the electrochemical processing unit, the operations comprising

extracting an amount of the electrochemical bath from the electrochemical processing unit for measurement of the amount of the first bath additive therein,

dispensing an amount of a virgin makeup solution that is saturated with the second bath additive into the container to form a mixed bath,

executing at least one electroanalytical measurement cycle using the mixed bath,

determining the amount of the first bath additive in the extracted electroplating bath using one or more measurements obtained in the at least one electroanalytical measurement cycle using the mixed bath.

18. The automated chemical management system of claim 17 wherein the first bath additive is an electroplating suppressor in the second bath additive is an electroplating enhancer.

19. The automated chemical management system of claim 17 wherein the electroanalytical measurement system executes cyclic voltammetric stripping.

20. The automated chemical management system of claim 17 wherein the electroanalytical measurement system executes cyclic pulse voltammetric stripping.

21. The automated chemical management system of claim 17 wherein the programmable control system determines the amount of the first additive by comparing one or more measurements obtained during the at least one electroanalytical measurement cycle to one or more measurements obtained using a standardized solution, the standardized solution comprising virgin makeup solution that is saturated with both the first and second bath additives.

22. The automated chemical management system of claim 17 and further comprising a chemical dosing system connected to dispense an amount of the first bath additive based on the amount of the first bath additive as determined by the programmable control system.

ABSTRACT OF THE DISCLOSURE

A method for determining the concentration of an additive X of an electrochemical bath that includes at least one further component Y is set forth. In accordance with the method, a predetermined amount of a starting solution is provided. The starting solution comprises virgin makeup solution that is saturated with the further additive, or forms a mixed solution that is saturated with the further additive when combined with an amount of the electrochemical bath for measurement that is extracted for measurement. A predetermined amount of the extracted electrochemical bath is then added to the predetermined amount of the starting solution to form the mixed solution. At least one electroanalytical measurement cycle it is then executed using the mixed solution and the results of the measurement cycle are compared with a known measurement standard.

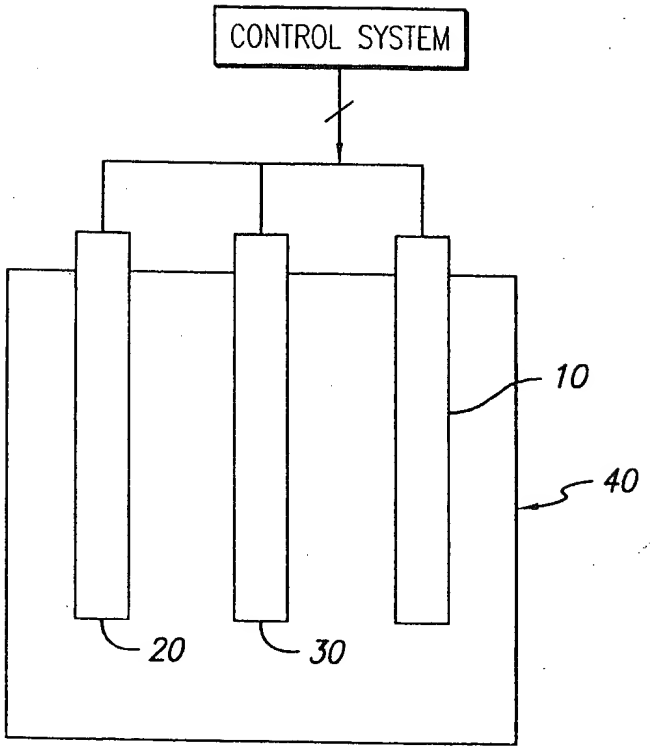


FIG. 1

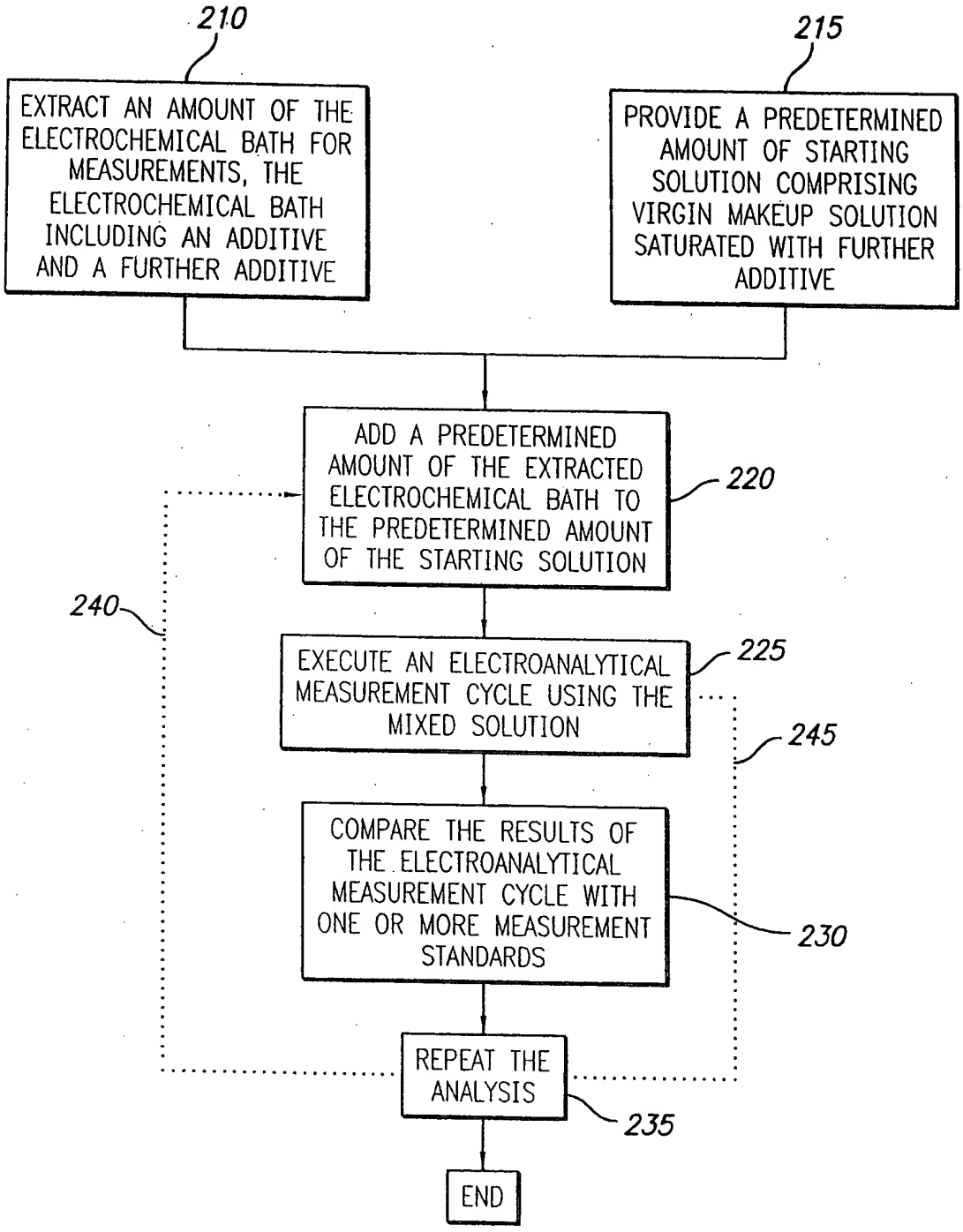


FIG. 2

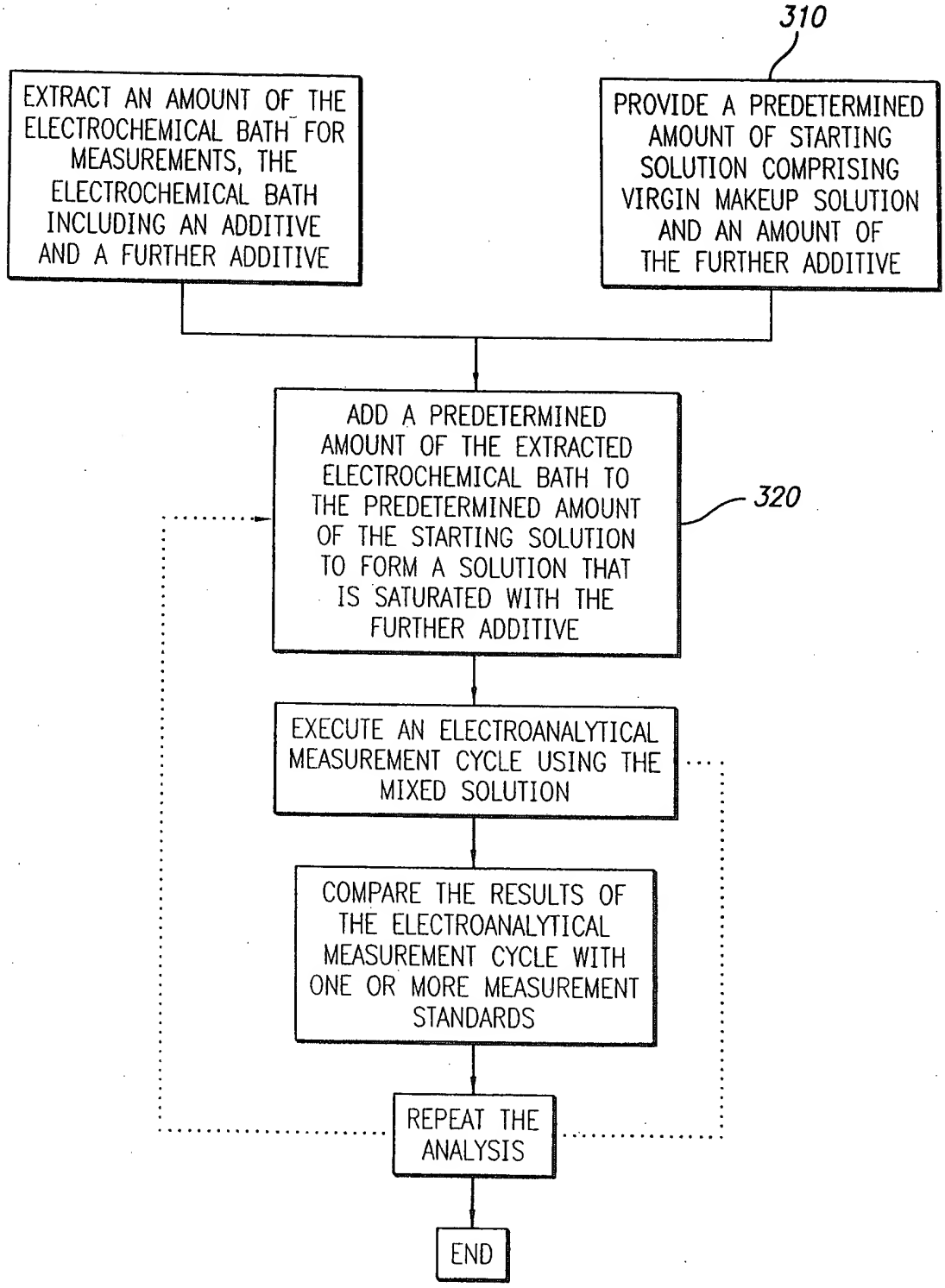
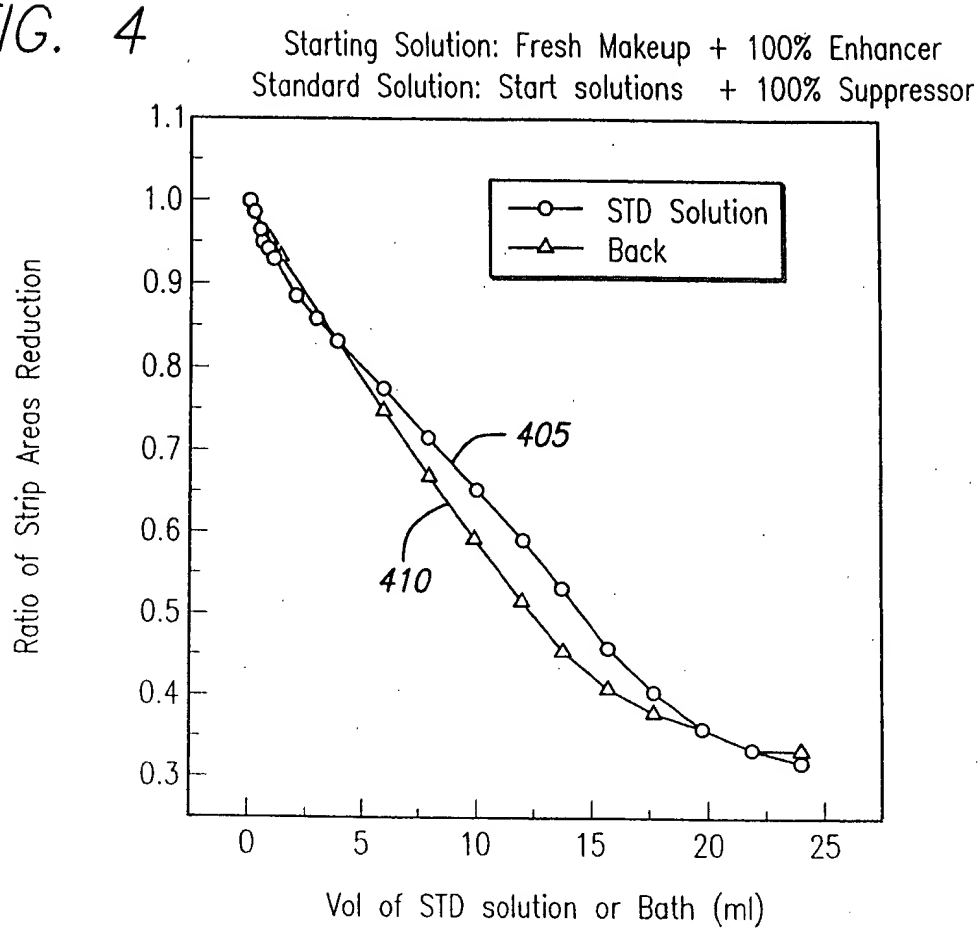


FIG. 3

FIG. 4



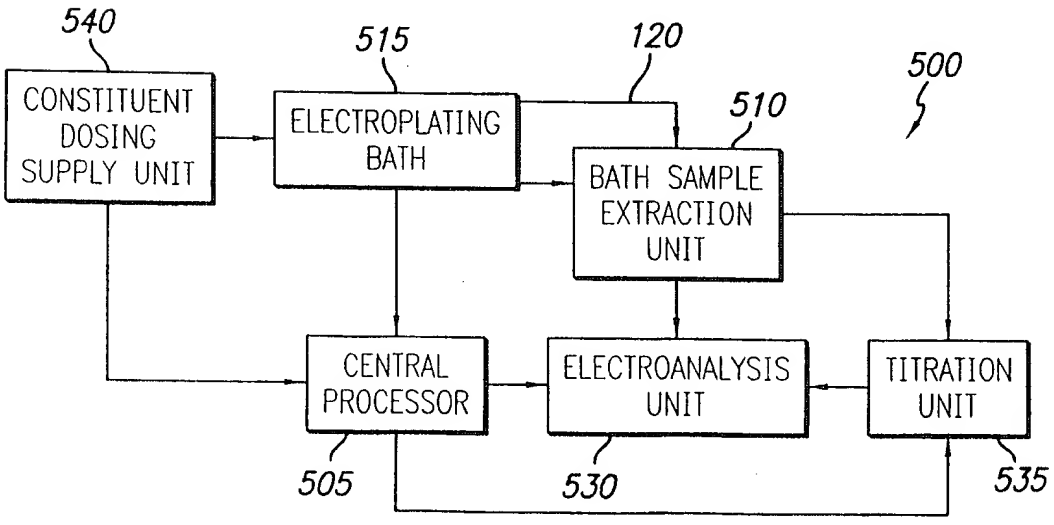


FIG. 5

PATENT APPLICATION
Atty. Docket No. 1921.0014C

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the PATENT application of

Linlin Chen et al.

Serial No.: 09/931,268 **Group/Art Unit: 1743**

Filed: August 16, 2001

For: Automated Chemical Management System Executing Improved Electrolyte Analysis Method

PRELIMINARY AMENDMENT

Mail Stop Non-Fee Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

Prior to examination, please amend the above-identified application as follows:

In the Specification:

Replace the first paragraph on page 1, lines 2- 6 with the following paragraph.

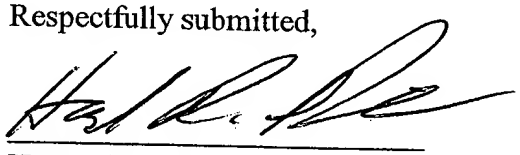
--This application is a continuation-in-part of ~~USSN~~ U.S. Patent Application Serial No. 09/387,084, filed 08/31/1999, titled "Methods and Apparatus for Controlling and/or Measuring Additive Concentration in an Electroplating Bath" (now issued as U.S. Patent No. 6,356,033), which is a continuation of PCT/US99/09659, filed 05/03/1999 and published in English under PCT Article 21(2), titled "Methods and Apparatus for Controlling and/or Measuring Additive Concentration in an Electroplating Bath", which claims priority from U.S. Provisional Patent Application Serial No. 60/083,882, filed May 1, 1998, entitled "Closed Loop Electrolyte Composition Monitoring and Control System for Copper Interconnect Applications". ~~both of which~~ The disclosures of these applications are incorporated herein by reference in their entireties.--

REMARKS

The specification of the subject application has been amended to update the status of co-pending U.S. Patent Application Serial No. 09/387,084 (which is now issued U.S. Patent No. 6,356,033). In addition, the specification has also been amended to show the full chain of priority of U.S. Patent No. 6,356,033 back to is original filings (PCT/US99/09659 and 60/083,882).

In view of the above, the present application should now be in condition for early action on the merits and a Notice of Allowance is earnestly solicited.

Respectfully submitted,



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Hand-delivered: June 25, 2003

Attorney Docket No. 29195-8183US
Semitool Ref No. P01-0006

I hereby certify that this correspondence is being transmitted via facsimile to the United States Patent and Trademark Office at (703) 872-9310, on:

Date: Nov 10, 2003 By: Melody J. Almberg
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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF:	LINLIN CHEN *ET AL.*	EXAMINER:	TA HSUNG TUNG
APPLICATION NO.:	09/931,268	ART UNIT:	1753
FILED:	AUGUST 16, 2001	CONF. NO:	2230

FOR: **AUTOMATED CHEMICAL MANAGEMENT SYSTEM EXECUTING IMPROVED ELECTROLYTE ANALYSIS METHOD**

Preliminary Amendment

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Prior to examination on the merits, please amend the claims in the above-identified application as follows:

In the Claims:

Following is a complete listing of the claims pending in the application, as amended:

1. (Original) A method for determining the concentration of an additive X of an electrochemical bath that includes at least one further component Y, the method comprising:

providing a predetermined amount of a starting solution, the starting solution comprising virgin makeup solution that is saturated with the further additive;

extracting an amount of the electrochemical bath for measurement;

adding a predetermined amount of the extracted electrochemical bath to the predetermined amount of the starting solution to form a mixed solution;

executing at least one electroanalytical measurement cycle using the mixed solution;

comparing results of the electroanalytical measurement cycle with a known measurement standard.

2. (Original) The method of claim 1 wherein a plurality of electroanalytical measurement cycles are executed using the mixed solution and wherein the mixed solution used in the electroanalytical measurement cycles comprises mixed solutions having different amounts of the extracted electrochemical bath added thereto.

3. (Original) The method of claim 1 wherein the at least one electroanalytical measurement cycle comprises cyclic voltammetric stripping.

4. (Original) The method of claim 1 wherein the at least one electroanalytical measurement cycle comprises cyclic pulse voltammetric stripping.

5. (Currently amended) The method of claim 1 wherein the known measurement ~~curve~~ standard is obtained by executing a plurality of electroanalytical measurement cycles using a standardized solution comprising virgin makeup solution that is saturated with the additive X and the further component Y.

6. (Original) The method of claim 1 wherein the additive X is an electroplating suppressor.

7. (Original) The method of claim 1 wherein the additive X is an electroplating suppressor.

8. (Original) A method for determining the concentration of supressor in an electroplating bath that also includes an electroplating enhancer, the method comprising:

providing a predetermined amount of a starting solution comprising virgin makeup solution that is saturated with the enhancer;

extracting an amount of the electroplating bath for measurement;

adding a predetermined amount of the extracted electroplating bath to the predetermined amount of the starting solution to form a mixed solution;

executing at least one electroanalytical measurement cycle using the mixed solution;

comparing results of the at least one electroanalytical measurement cycle with a known measurement curve.

9. (Original) The method of claim 8 wherein a plurality of electroanalytical measurement cycles are executed using the mixed solution and wherein the mixed solution used in the electroanalytical measurement cycles comprises mixed solutions having different amounts of the extracted electroplating bath added thereto.

10. (Original) The method of claim 8 wherein the at least one electroanalytical measurement cycle comprises cyclic voltammetric stripping.

11. (Original) The method of claim 8 wherein the at least one electroanalytical measurement cycle comprises cyclic pulse voltammetric stripping.

12. (Original) The method of claim 8 wherein the known measurement curve is obtained by executing a plurality of electroanalytical measurement cycles using a standardized solution comprising virgin makeup solution that is saturated with the enhancer and suppressor.

13. (Currently amended) A method for determining the concentration of an additive X of an electrochemical bath that includes at least one further component Y, the method comprising:

providing a predetermined amount of a starting solution, the starting solution comprising virgin makeup solution that includes a predetermined amount of the further ~~additive~~component Y.

extracting an amount of the electrochemical bath for measurement;

adding a predetermined amount of the extracted electrochemical bath to the predetermined amount of the starting solution to form a mixed solution, the mixed solution being saturated with the at least one further component Y;

executing at least one electroanalytical measurement cycle using the mixed solution;

comparing results of the electroanalytical measurement cycle with a known measurement standard.

14. (Original) A method for determining the amount of an electrochemical bath additive that is to be automatically added to an electrochemical bath by a dosing system, the amount of the electrochemical bath additive that is to be added being

dependent on a measurable value related to an amount of a component X in the electrochemical bath, the electrochemical bath also including at least one further component Y, the method comprising:

providing a predetermined amount of a starting solution, the starting solution comprising virgin makeup solution that is saturated with the further component Y;

automatically extracting an amount of the electrochemical bath for measurement;

automatically adding a predetermined amount of the extracted electrochemical bath to the predetermined amount of the starting solution to form a mixed solution;

automatically executing at least one electroanalytical measurement cycle using the mixed solution;

automatically using the results of the electroanalytical measurement cycle to determine the amount of additive that is to be dispensed by the dosing system.

15. (Original) The method of claim 14 wherein the electroanalytical measurement cycle comprises cyclic voltammetric stripping.

16. (Original) The method of claim 14 wherein the electroanalytical measurement cycle comprises cyclic pulse voltammetric stripping.

17. (Currently amended) An automated chemical management system comprising:

a bath ~~extraction system~~ extractor connected to extract an amount of an electrochemical bath from an electrochemical processing unit, the bath ~~extraction unit~~ extractor being adapted to extract an electrochemical bath that is comprised of a first bath additive, the amount of which is to be determined by the automated chemical management system, and a second bath additive,

an electroanalytical measurement system including a container in which electroanalytical measurements are conducted, the container being adapted to hold an amount of virgin makeup solution that is saturated with the second bath additive,

a programmable control system connected to control the bath ~~extraction system~~ extractor and the electroanalytical measurement system, the programmable control system being programmed to direct the bath ~~extraction system~~ extractor and electroanalytical measurement system for execution of a series of operations to determine the amount of the first bath additive in the electrochemical bath that has been extracted from the electrochemical processing unit, the operations comprising

extracting an amount of the electrochemical bath from the electrochemical processing unit for measurement of the amount of the first bath additive therein,

dispensing an amount of a virgin makeup solution that is saturated with the second bath additive into the container to form a mixed bath,

executing at least one electroanalytical measurement cycle using the mixed bath,

determining the amount of the first bath additive in the extracted electroplating bath using one or more measurements obtained in the at least one electroanalytical measurement cycle using the mixed bath.

18. (Original) The automated chemical management system of claim 17 wherein the first bath additive is an electroplating supressor in the second bath additive is an electroplating enhancer.

19. (Original) The automated chemical management system of claim 17 wherein the electroanalytical measurement system executes cyclic voltammetric stripping.

20. (Original) The automated chemical management system of claim 17 wherein the electroanalytical measurement system executes cyclic pulse voltammetric stripping.

21. (Original) The automated chemical management system of claim 17 wherein the programmable control system determines the amount of the first additive by comparing one or more measurements obtained during the at least one electroanalytical measurement cycle to one or more measurements obtained using a standardized solution, the standardized solution comprising virgin makeup solution that is saturated with both the first and second bath additives.

22. (Currently amended) The automated chemical management system of claim 17 and further comprising a chemical dosing system connected to dispense an amount of the first bath additive based on the amount of the first bath additive in the extracted electroplating bath as determined by the programmable control system.

REMARKS

The present amendment amends claims 5, 13, 17, and 22. These amendments are largely cosmetic in nature and do not limit the scope of the claims in any way. To the contrary, some of the amendments actually broaden the original claim scope.

Applicants respectfully request consideration of the application in view of this preliminary amendment. If the Examiner has any questions or matters that can be expediently handled by telephone, he or she is encouraged to contact the undersigned at (206) 359-3848.

Respectfully submitted,
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Date: 10 Nov 03

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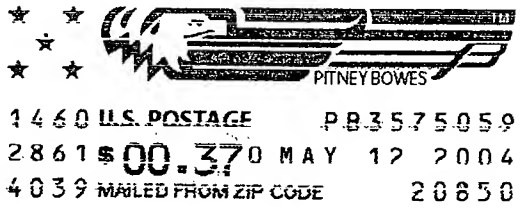

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